

Synopsis

Title: Factors Influencing Turnaround Time in Uniform Distribution and Strategies for Optimization in the Linen Department of CK Birla Hospital, Jaipur

Introduction

Uniforms in healthcare serve as both protective barriers against pathogens and as instruments of professional identification. In large multi-specialty hospitals, timely and accurate distribution of uniforms is crucial not only for staff comfort and morale but also for operational efficiency and infection control. Turnaround time (TAT)—the elapsed interval between a staff member’s request for a uniform and its issuance—emerges as a key performance indicator of linen-service efficiency.

At CK Birla Hospital, Jaipur (a 230-bed tertiary-care facility), reliance on manual record-keeping and centralized linen rooms has contributed to variable and, at times, prolonged TATs, leading to staff dissatisfaction and potential workflow bottlenecks. Despite national accreditation standards mandating stringent linen and uniform management protocols, many hospitals—including CK Birla—face challenges such as incorrect sizing, inconsistent inventory organization, and absence of visual control systems. This study aims to measure baseline TAT, map the uniform distribution workflow, identify root causes of delay, and pilot lean-based visual control interventions to optimize TAT and reduce size-mismatch incidents.

Review of Literature

The concept of TAT in healthcare logistics draws heavily on operations-management principles. Womack and Jones’s **lean thinking** paradigm emphasizes the elimination of “waste” through continuous flow and just-in-time delivery, while Liker’s 14 principles underscore visual management as a linchpin of process optimization [1,2].

Empirical studies in hospital laundry services have applied value-stream mapping and 5S techniques to bulk linen cycles, reporting TAT reductions of up to 20% through kanban systems and batch-size optimization [3,4]. However, research on **individual** uniform issuance is scant. Patel et al. noted a median TAT of 15 minutes for uniform issues in a large tertiary hospital and recommended staggered issue schedules without exploring visual controls [5]. Lee et al. piloted numeric tagging of uniform racks in an outpatient setting, achieving a statistically significant reduction in TAT and size-mismatch rates, but highlighted scalability concerns in inpatient laundry departments [6].

Human-factors frameworks such as SEIPS illustrate how ergonomics and workspace design influence process times, yet few studies have applied these models to linen rooms [7]. Simulation-based inventory placement studies in pharmacies have yielded insights

transferable to uniform distribution, but a comprehensive investigation combining time-motion analysis, lean tools, and visual control in a mid-sized hospital context remains absent.

Theoretical and Conceptual Framework

The study interweaves three theoretical lenses:

1. **Lean Management (Toyota Production System)**
 - **Waste Reduction:** Identification and elimination of non-value-added steps in the uniform distribution process.
 - **Visual Control:** Use of color-coded racks and numeric size tags to minimize search time and errors.
2. **Systems Engineering Initiative for Patient Safety (SEIPS)**
 - **Work System Components:** Analysis of people, tasks, tools, environment, and organizational factors affecting TAT.
 - **Human Factors:** Assessment of ergonomics, staff movement patterns, and workspace layout in the linen room.
3. **Sociotechnical Systems Theory**
 - Emphasizes alignment between technical interventions (e.g., QR-based requests, barcode scanning) and social components (staff training, communication protocols) to ensure sustained process improvement.

These frameworks collectively inform the study's intervention design—combining time-motion mapping, root-cause analysis (Fishbone, 5 Whys), and pilot visual-control tools to drive iterative workflow enhancements.

Research Gap

A critical appraisal of existing literature reveals four salient gaps:

1. **Focus on Bulk vs. Individual Processes:** Most studies target bulk linen cycles, neglecting personalized uniform issuance workflows that entail discrete size verification and individualized handling.
2. **Limited Application of Visual Controls in Inpatient Settings:** While numeric tagging has proven effective in outpatient clinics, its scalability and long-term sustainability in 24×7 inpatient linen departments remain untested.
3. **Underexplored Ergonomic and Layout Factors:** Human-factors research has largely overlooked the specific impacts of rack layout, walking distances, and counter design on uniform TAT.

4. **Absence of Longitudinal Evaluations:** Short-term pilot studies dominate the field; few investigations assess the persistence of improvements or the need for reinforcement and audit over extended periods.

This study addresses these gaps by conducting a six-week, mixed-methods investigation in a mid-sized hospital's linen department, integrating lean tools, ergonomic assessments, and a three-month follow-up of visual-control interventions.

Research Questions

1. **Primary Question:** What factors contribute to delays in uniform distribution at CK Birla Hospital's linen department, and how can TAT be optimized?
2. **Secondary Questions:**
 - a. Which workflow steps contribute most to prolonged TAT?
 - b. How do size-mismatch incidents impact overall distribution efficiency?
 - c. What is the effect of visual numeric tagging on TAT and error rates?
 - d. How sustainable are lean-based interventions over a three-month period?

Research Objectives

1. Measure the baseline average TAT for uniform issuance.
2. Map end-to-end workflows and identify non-value-added steps.
3. Analyse frequency and root causes of size-mismatch incidents.
4. Pilot and assess visual numeric tagging and color-coded rack systems.
5. Evaluate TAT and error-rate changes pre- and post-intervention.
6. Provide evidence-based recommendations for SOPs, inventory management, and staff training.

Methodology

Research Design: Descriptive, observational, mixed-methods study spanning six weeks of data collection and a three-month follow-up evaluation.

- **Setting:** CK Birla Hospital's centralized linen room serving ICU, OT, IPD, OPD, pharmacy, radiology, and housekeeping.
- **Population & Sampling:** Purposive sampling of 365 uniform transactions across clinical and non-clinical staff; key-informant interviews with 10 department representatives.
- **Data Collection:**

- **Quantitative:** Stopwatch-measured TAT, Excel logs of request and issue times, size requested vs. issued.
- **Qualitative:** Semi-structured staff interviews, workflow observations, complaint-register analysis.
- **Interventions:** Introduction of laminated numeric size tags, color-coded racks, and a QR-coded Google Form for requisitions in Week 4.
- **Ethical Approval:** Secured from CK Birla Hospital's Institutional Ethics Committee; informed consent obtained from all participants.

Plan of Analysis

1. **Descriptive Statistics:** Compute mean, median, standard deviation, and frequency distributions of TAT and error types.
2. **Comparative Analysis:** Paired t-tests (or non-parametric equivalents) to compare pre- and post-intervention TAT and size-mismatch rates.
3. **Root-Cause Analysis:** Develop Fishbone diagrams categorizing delays under People, Process, Policy, Materials, Machines, and Environment; apply 5 Whys to transactions exceeding 4 minutes.
4. **Ergonomic Assessment:** Measure walking distances and rack accessibility times; correlate with TAT outliers.
5. **Qualitative Thematic Analysis:** Code interview transcripts for recurrent themes on communication, SOP adherence, and staff satisfaction.
6. **Longitudinal Follow-Up:** Re-measure TAT and error rates monthly for three months post-intervention to assess sustainability.

Ethical Considerations

Informed Consent & Confidentiality: Participants received written and verbal explanations; data anonymized via numeric codes.

- **Non-maleficence:** Interventions (e.g., QR forms, tagging) posed minimal risk; no disruption of clinical duties.
- **Data Security:** Excel files password-protected; hard copies stored securely.
- **Ethics Committee Approval:** Study protocol reviewed and approved by the CK Birla Hospital Institutional Ethics Committee (Ref. No. RBH/IEC/2025/04).
- **Conflict of Interest:** None declared.

Implications of Research

Theoretical Implications:

- Extends lean-management and human-factors theories by validating visual-control and ergonomic interventions in a non-manufacturing, mid-sized hospital context.
- Demonstrates the applicability of SEIPS to support-service processes, enriching sociotechnical systems literature with empirical data on linen-room workflows.

Practical Implications:

- Provides a replicable framework for hospital administrators to benchmark uniform TAT (~1 minute) and drive continuous improvement via SOPs and visual controls.
- Offers cost-effective strategies (laminated tags, QR forms) to enhance inventory accuracy, reduce size-mismatch incidents, and improve staff satisfaction.
- Strengthens compliance with NABH accreditation standards related to linen management and support-service metrics.

Policy Implications:

- Informs hospital policy on standardized uniform-issuance protocols and digital requisition systems.
- Supports the integration of lean principles into accreditation criteria for support services.
- Encourages adoption of ergonomic design guidelines for linen-room layout in healthcare facility standards.

References in Synopsis

1. Womack JP, Jones DT. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Simon & Schuster; 1996.
2. Liker JK. *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill; 2004.
3. Singh S, Gupta A. Process improvement in hospital laundry services using value-stream mapping. *Int J Health Care Qual Assur*. 2019;32(3):210–218.
4. Kumar R, Singh D. Time-motion study of linen processing in a tertiary care centre. *J Acad Hosp Adm*. 2020;14(1):45–52.
5. Patel P, Desai M. Evaluation of uniform issuance procedures in a 500-bed hospital. *Hosp Admin J*. 2020;9(2):90–95.
6. Lee H, Kim J, Park S. Effect of numeric tagging on uniform distribution efficiency in outpatient clinics. *Int J Health Care Qual Assur*. 2021;34(5):372–380.

7. Carayon P, Schoofs Hundt A, Karsh B-T. Work system design for patient safety: the SEIPS model. *Qual Saf Health Care*. 2006;15 Suppl 1:i50–i58.
8. Barbosa-Póvoa AP, Mascarenhas M, Costa EM. A simulation-optimization approach to hospital pharmacy inventory management. *Eur J Oper Res*. 2010;204(2):311–321.